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REV. J. L. ZABRISKIE,

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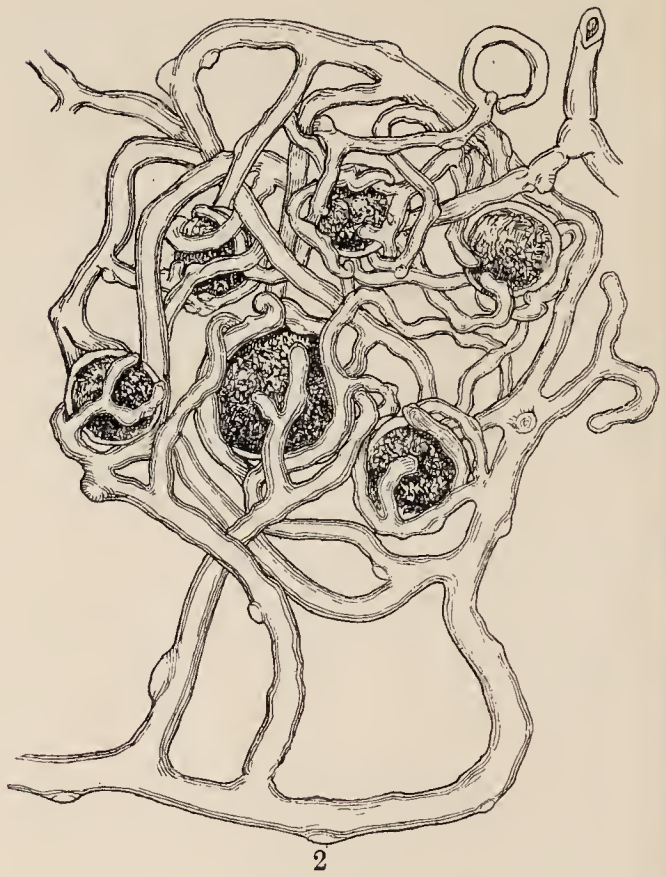

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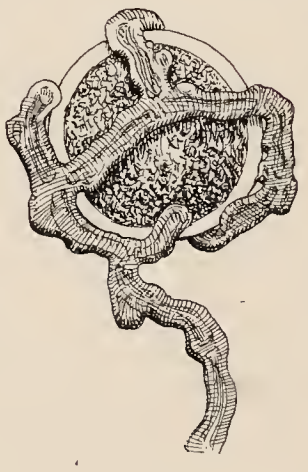

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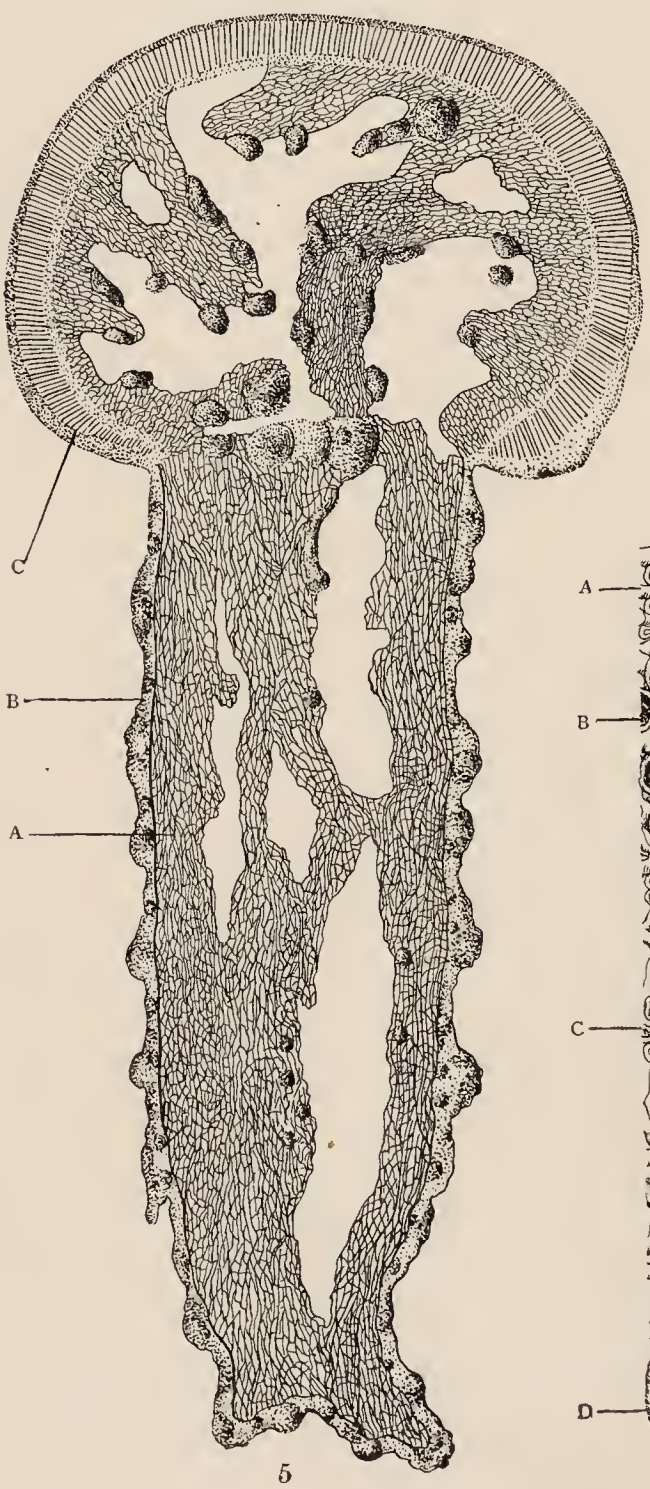

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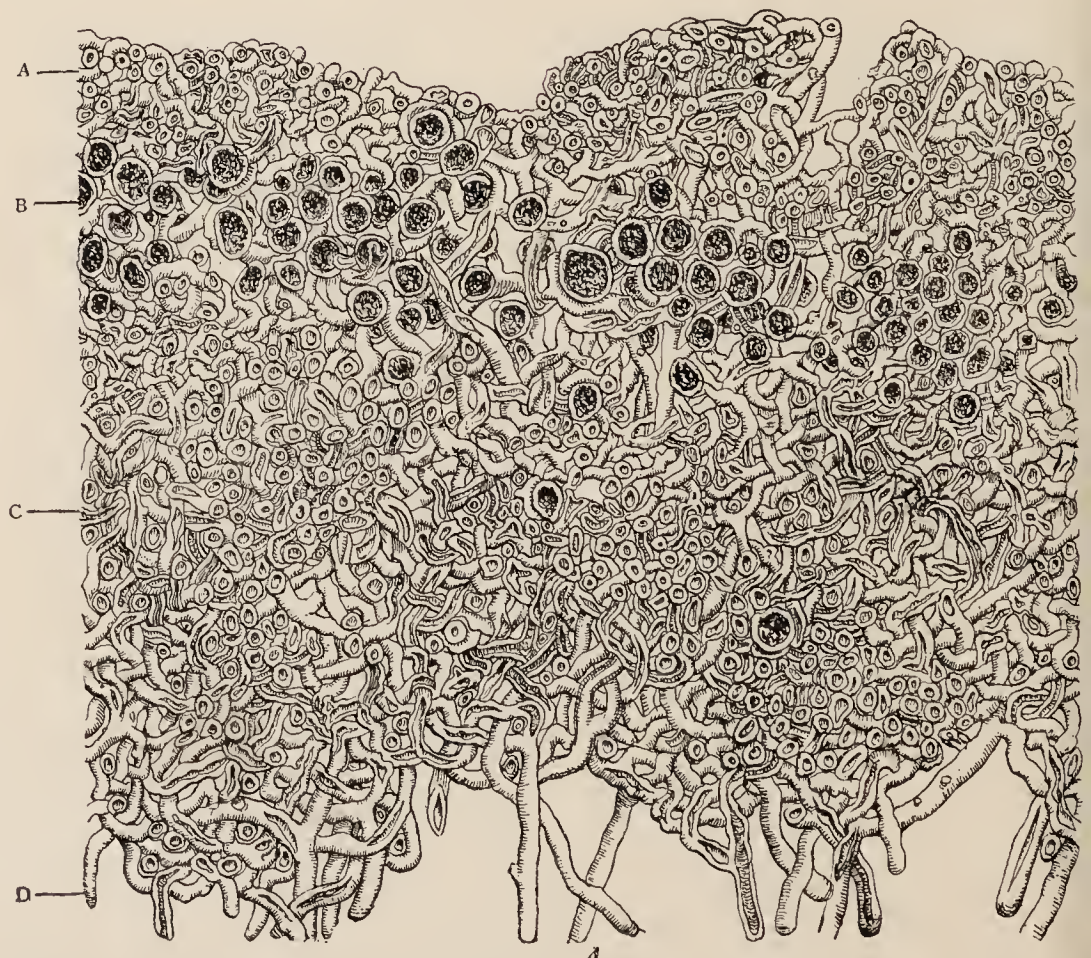

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THE LICHEN THALLUS.

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VOL. X. JULY, 1894. No. 3.

A CONTRIBUTION TO THE HISTORY OF THE FORMATION OF THE LICHEN THALLUS.

BY CARLTON C. CURTIS.

(*Read March 16th*, 1894.)

About five months ago some material was brought into our laboratory that proved to be an exceedingly early stage in the development of the lichen thallus. The observations on, and illustrations of, this condition and subsequent development that have extended down to the time of writing are here presented, not as any considerable addition to the subject of lichenology, but because the study awakened much interest among the students, and some points were made clearer than could be gathered from the literature of the subject, and, as far as known, there are no

Explanation of Plate 44.

FIG. 1.—Filament of the fungus attacking an algal cell.

FIG. 2.—The subsequent development of the form shown in Fig. 1. The algal cell has divided several times, and the hyphæ have extended themselves to form a bushy cluster.

FIG. 3.—A still older growth. The clusters are becoming covered above and below with a mass of filaments.

FIG. 4.—A longitudinal section through the young thallus. *a*, Upper medulla; *b*, gonidial or algal zone; *c*, lower medulla; *d*, rhizoids.

FIG. 5.—A longitudinal section through a sporocarp. *a*, The dense tissue of the stipe—the lines are not intended to represent the structure; *b*, the gonidia largely confined to the periphery of the sporophore; *c*, hymenium—the dotted portion representing the paraphyses projecting beyond the asci.

FIG. 6.—A longitudinal section of the apothecium. *a*, Paraphyses; *b*, ascus with spores; *c*, hypothecium—the hyphæ anastomose more than is indicated; *d*, a small gonidial group.

records of this early condition occurring in a state of nature. For, since the time when lichens were styled aërial algæ, down to the time when Schwendener termed them autonomous, so much of error was published that there can be no fear of augmenting this dark but suggestive page of botanical history. On the other hand, the histological work of De Bary[1] and Schwendener,[2] the analytical researches of Famintzin and Baranetzki,[3] and the brilliant and successful synthetic labors of Rees,[5] Treub,[10] Bornet,[4] and Stahl,[6] from their thoroughness and scientific methods, preclude the addition of material truth either to theory or facts of the subject. And in our own day the ingenious investigations of M. G. Bonnier[7] on the protonema of several mosses should be included as worthy of mention with these latter scholars. Perhaps no department of scientific research can present such a flood of false observation and theory; certainly none can show such dogged resistance to the truth or more brilliant and scientific work in its establishment. These early lichenologists, confining themselves narrowly to their subject and unacquainted with its biological relationship, compiled volumes, tomes, and libraries totally ignorant of the real nature of the subject under discussion. And to them came the truth like the awakening from a dream. They could not at first believe that their work was all a myth, and later would not. And so not till comparatively very recent times, though demonstrated beyond peradventure of a doubt by the histologist and physicist, has the truth been accepted.

When first gathered the material bore a close resemblance to *Protococcus viridis* Ag. as it often appears growing on trees and stones in damp places. But under the glass it aroused the wonder of all who saw it, none the less from its strange and unexpected appearance than from the beauty and elegance of its form. Here could be seen the white, almost hyaline mycelium becoming excessively branched and forming bushy, spherical masses of hyphæ, in whose ultimate ramifications were held the round, emerald-green algal cells (Plate 44, Fig. 2). Not yet were the gonidia obscured by the filaments, and the branching and method of growth were easily followed. In nearly every group could be found one or more algal cells, somewhat removed from the cluster, and showing clearly how they are seized by the

hyphæ. With the formation of each new cell either a branch from the filament encircling the mother cell or from the mycelium is put out to get possession of it. At the moment of union an unmistakable quickening is manifest both in host and parasite. The latter puts out, at a short distance from the alga, from one to several branches that follow the main fibril and encircle the alga in various windings (Fig. 1). The alga greatly increases in size, and the early growth often suggests a strong resemblance to the fingers of a hand closing about a ball. The gonidia often attain a diameter of twenty μ, averaging about nine μ, thus exceeding the size of *Protococcus viridis* Ag. by about two μ. In the more mature thallus the crowding and subsequent distortion give them a somewhat smaller appearance. The activity of the fungal hyphæ was apparently due to the food furnished by the algæ. The increase of the algæ, however, seemed due rather to some stimulus or irritation of the hyphæ than to any food supplied to them. In this early stage it cannot be doubted that the algæ are often removed some distance from the parent cells and become the centres of new clusters, which in fact could be found in all stages of growth, showing from one to many gonidia. These clusters by their increase finally anastomose, forming a more or less entire surface from which the characteristic thallus develops. That this was not the usual method of extension will be seen below, and it was also manifest from the numerous germinating spores that often appeared in the clusters, and also from the tendency of the free mycelium to turn back toward its cluster soon after its exit. While the spore (Fig. 6) was the prevalent one, there also appeared two other forms, some of which had germinated. Owing, however, to the entanglement of the filaments it was impossible to see how extensive was the growth of the odd spores. And the question arises whether the hyphæ of various spores may enter into the structure of a lichen, and the dominant one characterize the resulting thallus. In looking at these clusters of filaments and algæ the thought often occurred that could Crombie have seen them he would not have made so spirited and bitter an attack upon the theory of Schwendener, nor would the latter have appeared so highly colored or poetical to him.[8]

After the young symbionts became accustomed to their new surroundings in the laboratory there soon was manifest the

characteristic structure of the lichen. The groups became covered above with a very dense growth of hyphæ; below, the mycelium kept pace and usually exceeded the growth above, but at the sides rarely did any considerable thickening of the filaments occur. So there was always room, not at the top, but at the sides for the extension of the mycelium with its captured cells. This new lateral extension would be woven over, almost as soon as formed, by the dorsal and ventral hyphal layers. The divisions and growth of the algæ were very rapid in the early stages, and this growth continued at the margins; but as the hyphæ, in the extension of the thallus, entangled them more and more in a dense mass, their activity lessened and finally stopped through the crowding of the surrounding filaments. It was apparent that division only ceased when all the space available to the algæ had been occupied. And so finally the form of the algæ was concealed by the mat of hyphæ above, through whose semi-transparent walls the color still shone. On the under side the thickened mass shut out cells and color alike, thus presenting a whitened surface. From this under side extended numerous strands of the mycelium, rhizoids, into the substratum. These roots were confined for the most part to the median and especially to the distal portions of the thallus, and were of the nature of holdfasts. A cross-section of the thallus (Fig. 4) now shows the hyphæ so closely woven together above as to render the form of the individual fibrils almost indistinguishable. Beneath are the crowded gonidia, forming a well-marked zone in which the original centres of growth are still indicated by group-like masses of algæ, though this latter arrangement is often obliterated by the broadening of the clusters and their consequent union. It will be noticed that scattered algal cells frequently appear in the ventral medulla and but very rarely in the dorsal. Thus again is it manifest that the transportation of the gonidial cells attendant upon growth depends upon their seizure by, and subsequent growth of, one of the hyphæ. The looseness of the subgonidial layer permits at many places of such a limited growth, while above there is rarely opportunity for a fibril with its host to crowd through. Mention should be made here of an exception to this rule. The gonidial zone occasionally extends quite to the upper surface of the thallus. At such places the unimpeded algæ may be carried out by

the hyphæ, forming an irregularity or projection upon the surface, or a branch of the thallus may start from such a point. In some sections there appeared connected with this feature small bundles of gonidia and hyphæ not unlike soredes. These may have been simply the beginnings of further growth. A somewhat similar growth appears on the sporophore referred to below. The peculiar configuration of the thallus that characterizes both the margin and surface of the mature lichen seems to be largely due to the behavior of the mycelium in blocking the growth of the gonidia with mats of filaments. This interposition of dense felts at various places on the margins results in a very irregular, almost ragged, outline of the thallus. I could not always satisfy myself that the lobing, particularly in the young thallus, was brought about in this manner; but its frequent observation leaves little room for doubt that the cause of the peculiar form of growth is as above stated.

The sporocarp appears to arise from a lifting up of the thallus, which, growing into a tubular mass, forms the receptaculum. Though diligent search was made for the archicarp in all these early stages of growth, not the slightest evidence of it could be found. Nor did any section show any trace of or give indication of sexuality. The hypothecium and paraphyses could be recognized at an early age, especially the latter, which appeared about as soon as there was any outward evidence of the sporocarp. The asci appeared much later, and in fact could not be recognized till the hymenium was developed and began to show its characteristic color. In this state the ascogenous hyphæ could not be traced into the subhymenial layer, and, in truth, had the same appearance as the filaments generating the paraphyses. The growth of the asci extended over a considerable period, new sacs appearing beside those apparently empty. The apothecia are spherical, surmounting the stipe like a cape, and of a brown color from the closely packed filaments of the hymenium. The receptaculum shows a marked variance in its structure from that of the thallus. As mentioned above, it is cylindrical, of especially dense tissue, the hollow central portion being traversed by irregular strands from the periphery. But, unlike the thallus, the gonidial layer is largely developed upon the outside. As soon as the filaments of the medulla begin to lift up to form the

stipe, the algæ are carried through to the outer surface and follow in luxuriant growth its upward course. Only a comparatively few scattering clusters occur in the discocarp and cavities and tissue of the stipe. On the periphery of the receptaculum, however, there is an unusual growth of algæ, loosely bound together, and sparingly covered by the filaments. Not a little attention was given to this peculiar development. The ease with which they could be separated, and the simplicity of their growth, readily suggested that they might be means of propagation, though the significance of their position on the stipe rather than on the thallus was not manifest. I can see only one explanation of this distribution of the gonidia—namely, that the algæ are massed along the stipe, exposed directly to the atmosphere, unrestrained in their growth by the pressure of a medulla, in order that they may be able to meet with an adequate food supply the heavy demands made upon their constructive metabolism by the ascogenous hyphæ. This appears to be an excellent illustration in vegetable physiology of adaptation to economic ends. And this seems the more probable as the rhizoids are the last stage in the reduction of root forms. Although the algæ are in a limited degree histological factors of the thallus, being dependent upon the fungi, it may be, for their ash constituents, nevertheless it is more in keeping with the nature and behavior of lichens to look upon the fungus simply as an obligate parasite and the alga as a host. And then again it was often observed that on the old sporophores the gonidial bundles began to grow after the manner first described, and at times quite covered the stipe with small thalli. This secondary growth on the receptaculum was not observed while the asci were still developing.

The results of the consortism of these two plants is particularly worthy of note. On the one hand, the fungus, delicate, a saprophyte, fond of darkness and dampness, and the alga, dependent upon shade and moisture, by their commensalism produce a plant independent of surroundings and organic substratum, capable of living upon crystalline rock or bark of tree or earth, enduring the extremes of heat and cold, neither dependent upon rain nor destroyed by drought. And this complete change of habit is not so striking as the behavior of these two lowly plants as symbionts. They at once catch the spirit that governs all higher vegetable

life, and whatever form they make take, whether foliaceous, fruticose, or crustaceous, they are always actuated by a principle new to their nature—the exposure of the chlorophyll to the light and atmosphere as much as possible. How important a force, then, is this commensalism! What part may it not have taken, fostered by natural selection, in the separation of forms? The behavior of the protonema of mosses and fungi; the transformation by algæ of some of the simpler animals[9] to forms widely different and independent of organic food absorption; the easy passage of the algæ to purely histological factors in the anatomy of the lichens—all suggest that this force of commensalism may have played a more important rôle and been a more potent factor in the determination of species than is ascribed to it. I am greatly indebted to Mr. A. E. Anderson for the greater part of the drawings. I also wish to acknowledge the valuable advice and assistance of Prof. N. L. Britton in the prosecution of the research work.

1. De Bary: Ueber die Erscheinung der Symbiose.
2. Schwendener: Ueber den Bau und das Wachsthum des Flechten-Thallus, etc.
3. Famintzin und Baranetzki: Zur Entwickelungsgeschichte d. Gonidien und Zoosporenbildung der Flechten.
4. Bornet: Recherches sur les Gonidies des Lichens.
5. Rees: Ueber die Natur der Flechten.
6. Stahl: Beitrage zur Entwickelungsgeschichte der Flechten.
7. Bonnier: Germination des Lichens sur les Protonemas des Mousses.
8. Körber: Zur Abwehr der Schwendener-Bornet'schen Flechtentheorie.
9. Brandt: Ueber das Zusammenleben von Thieren und Algen.
10. Treub: Lichencultur.

NOTES ON THE STAINING OF CELLULOSE.

BY E. G. LOVE, PH.D.

(*Read April 20th*, 1894.)

Cellulose forms the basis of vegetable tissues, and also occurs to a slight extent in animal membranes. It is composed of carbon, hydrogen, and oxygen, and its composition is the same as that of starch.

In chemistry the words cellulose and lignin are often used as synonymous terms. It is preferable, however, to restrict the word lignin, as is commonly done in microscopy, to those older growths of the cell usually known as lignified or woody tissue, in which the original cell has received secondary deposits, and has as a whole been more or less changed in composition and reactions from cellulose.

Cellulose as it occurs in plant structures presents considerable variety in physical properties. Sometimes it is soft, as in the young plant, and again it is quite dense. This fact accounts for the varying results obtained when cellulose is subjected to the action of staining liquids.

The staining of young and soft cellular tissue presents no special difficulties, but when the cellulose increases in density the difficulty is increased ; and this is true whether the cellulose is in a nearly pure condition, as in the cotton fibre, or in the modified condition of lignin or woody fibre. Stains which readily attack young cellulose tissue have practically no effect upon it in its maturer form.

Some time ago I had occasion to make a series of tests on the comparative value of several stains in the staining of cellulose and lignin as found in textile and woody fibres ; and as the information on this subject in the books is very limited, it was thought that the matter might be of sufficient interest to bring some of the results before the Society.

It is of course important, in the staining of fibres for microscopic examination, that they shall take the stain uniformly. In com-

mercially dyed fabrics this will often be found to have been done very imperfectly. Thus a piece of Turkey red appears in the piece to be well dyed, and practically it is; but when examined microscopically it will be found that the individual fibres have taken the dye very unevenly. This is often the case with fabrics, especially cotton and linen, which have been dyed in the piece; whereas if the fibre is dyed before weaving, as in the ginghams, the result on the individual fibres is more uniform.

A mordant is a substance which has an affinity for both organic tissues and coloring matters, and which by virtue of this property is employed in dyeing to fix the color upon the tissue.

The most common mordant in staining microscopic preparations is alum, a solution of which is usually mixed with the stain previous to its application. Other substances, as dilute solutions of organic and mineral acids, are sometimes used under the name of "fixers." Their action is seldom that of a true mordant, their efficiency, when they possess any, being confined to some decomposition of the coloring matter or to some action upon the tissue itself.

In staining animal and vegetable sections some stains require a mordant, while others do not. Thus hæmatoxylin, or the staining principle of logwood, is often used without a mordant, while most of the carmine stains require one.

The staining of tissues may be effected in four ways. First, when the stain has sufficient affinity for the tissue to be retained by it without the intervention of any outside agent. Second, when the stain and mordant are mixed and applied to the tissue in one solution. These two are the simplest and easiest methods of staining. Third, when the tissue is first immersed in the staining liquid and then transferred to some other liquid which shall fix the color upon the tissue. Fourth, when the tissue is first impregnated with the mordant, or fixing agent, and then immersed in the stain. The last method is the one usually followed in commercial dyeing establishments, and is to be recommended in the staining of microscopical preparations which do not readily take the stain.

It is easy to see that, in substances which are difficult to stain, there is less chance of effecting the object when the mordant and stain are both presented to the object at the same time, than when

it is first impregnated with the mordant and then brought into contact with the stain. The tests which I have made, and the specimens which are here for examination, amply prove this. They include a large number of specimens illustrating the action of the different stains upon cotton and linen fabrics, and in some cases upon woody fibres also. Some specimens show the effect of the stains when used alone, while others show the effect of the same stains when used in connection with different mordants. The mounted preparations placed under the several microscopes show the microscopic appearance of some typical specimens of these stained fibres.

Grenacher's Carmine is a solution of carmine in alum, which one authority states will stain cellulose a fine red, but does not stain lignified or suberized tissues. This clearly refers to cellulose as it occurs in soft vegetable tissues, and the same doubtless applies to the staining of cellulose as described in works on the subject. Cotton and linen fibres which were immersed in this stain for twelve hours and washed in water had only a slight reddish tint. The fibres were then immersed in the stain for fifty-four hours with no better result.

Thiersch's Carmine is a solution of carmine with oxalic acid. Cotton fibre was immersed in this stain for eighteen hours and washed. It had a dull rose color, which was very faint when seen in individual fibres as in the mounted preparation.

Borax Carmine.—The result with this stain both upon cotton and linen fibres was about the same as with Grenacher's carmine. Oxalic acid was used as a "fixing" agent.

Logwood and Brazilwood.—In the tests which were made with these dyes I used a tincture obtained by soaking the chips in strong alcohol, and filtering when necessary.

As already stated, hæmatoxylin, or logwood stain, can often be used without a mordant in the staining of vegetable sections, but when applied to cellulose fibres it is almost without action.

A common preparation of hæmatoxylin for staining purposes is its solution with alum. This is claimed to stain both cellulose and lignified tissue, but not suberin. When cotton fibre is immersed in this solution for four hours it is very fairly stained, and when mounted in balsam has a light blue color. If the fibre

is first mordanted and then stained, almost any depth of color can be obtained.

The mordants tried were alum, acetate of alumina, sulphate of copper, and acetate of copper. These were used in strong solutions.

The solution of acetate of alumina is readily prepared by adding a solution of acetate of lead to one of alum (leaving the alum slightly in excess), and filtering.

The fibre was soaked in the mordant for about an hour, the excess squeezed out, and the fibre then immersed in the alcoholic solution of the dye-wood for an hour or longer as the case required.

The uniform staining of the fibre is facilitated by moving it about while in the mordanting and in the staining solutions.

As will be seen from the specimens, there is practically little difference between the results obtained with the different mordants and logwood. Alum and acetate of alumina give a purple shade, while the copper mordants give a decided blue. With brazilwood the fibres mordanted with alum are not so deeply stained as when the other mordants are employed.

Of the four mordants tried the preference must be given to the acetates of alumina and copper. This accords with the general practice in dyeing establishments. The reason is that the acetates are less stable compounds than the sulphates, and consequently yield the bases, alumina and copper oxide, more readily to the fibre.

The specimens of cotton fibre dyed with brazilwood illustrate this very clearly, those mordanted with the acetates being of a much deeper shade than those in which the sulphates were used.

For lignified fibres there is no better stain than logwood, with the previous mordanting of the fibre. With the mordant and stain combined in one solution the result was not satisfactory, some fibres being fairly well stained while others were not stained at all.

The mordants already mentioned were tried on a variety of woody fibres with both logwood and brazilwood, but I submit for your examination only those of spruce and poplar. It will be seen from the specimens and slides that the fibres have taken the stain very uniformly.

Anilin Stains.—Satisfactory results in staining cellulose and

lignified fibres can be obtained by means of the anilin colors. In my experience, however, the staining of lignified fibres is not in all cases as uniform as is desirable.

When applied without a mordant, the fibre is only slightly stained, and a mordant is therefore necessary in order to obtain a stain sufficiently deep and permanent.

In some cases this may be effected by staining first and then mordanting, but, as already stated, it is better in the staining of fibres to reverse this order and apply the mordant first. In this way the staining may be effected in less time and the fibre be more deeply stained.

The method of mordanting the fibre was as follows : It was first immersed in a ten per cent solution of tannic acid for about an hour, the excess squeezed out, then placed in a one per cent solution of stannate of soda for about thirty minutes, transferred to water acidulated with sulphuric acid for a moment, washed in water, and placed in the stain for fifteen to thirty minutes, and finally well washed. The times here given for the action of the different solutions can be shortened in many cases.

A solution of tartar emetic, or tartrate of antimony and potash, was substituted in some experiments for the stannate of soda, but I think the latter is to be preferred for the reason that the tartrate solution soon develops fungous growths.

The list of anilin colors available for staining purposes is quite a long one. I have tried some six or eight of these, but will refer to only four, all of which have given good results and furnish all needed variety in color.

These stains were tried with cotton, linen, and spruce fibres, and the mixed fibre obtained from a sample of filter paper, and the specimens and slides here show the results obtained.

Fuchsin.—This was used in an aqueous solution containing 0.25 gramme in 100 c.c. of water.

I may mention parenthetically that this stain when properly applied is the best material I have found for staining wool fibres so as to bring out distinctly the structure of the scales. A slide containing some of these stained fibres will be found under one of the microscopes.

Hofmann's Violet.—This was used in a strong alcoholic solution. Unmordanted cotton fibre is stained a very light blue,

which when mounted for the microscope appears quite colorless. The fibre, when mordanted in the manner described, takes a deep blue.

Methyl Green —This is a favorite stain, especially for vegetable sections, and it is very effective in double staining. When applied to fibres, whether of pure cellulose or of lignin, it produces a deep green if the fibre has been mordanted before staining, while a light green is produced when the order of stain and mordant is reversed. It was applied in a strong aqueous solution.

Paris Violet.—This is a strong staining medium, readily imparting its color to almost all fibres, but requiring thorough mordanting to render it permanent.

It was used in a concentrated aqueous solution. As will be seen from the specimens, the result is a decided violet, differing in this respect from the bluer shade obtained with Hofmann's violet.

LIST OF ILLUSTRATING SPECIMENS.

Where stain and mordant were applied separately, the former is italicized.

Cotton fibre, stained with Grenacher's carmine.
Linen " " " " "
Cotton " " " Thiersch's "
" " " " borax "
Linen " " " " "
Cotton " " " alum and logwood in one solution.
" " " " alum and *logwood* in separate solutions.
" " " " acetate of alumina and *logwood*.
" " " " sulphate of copper and *logwood*.
" " " " acetate of copper and *logwood*.
Linen " " " " " "
Cotton " " " alum and *brazilwood*.
" " " " acetate of alumina and *brazilwood*.
" " " " sulphate of copper and *brazilwood*.
" " " " acetate of copper and *brazilwood*.
Spruce " " " alum and *logwood*.
" " " " acetate of alumina and *logwood*.
" " " " acetate of copper and *logwood*.
Poplar " " " alum and *logwood*.
" " " " acetate of alumina and *logwood*.
" " " " acetate of copper and *logwood*.
Spruce " " " alum and *brazilwood*.
" " " " acetate of alumina and *brazilwood*.
Poplar " " " alum and *brazilwood*.

Poplar fibre, stained with acetate of alumina and *brazilwood*.
Cotton " " " *fuchsin* and tannic acid and tartar emetic.
" " " " tannic acid and stannate of soda and *fuchsin*.
Linen " " " *fuchsin* and tannic acid and tartar emetic.
" " " " tannic acid and stannate of soda and *fuchsin*.
Cotton " " " *Hofmann's violet*, no mordant.
" " " " tannic acid and stannate of soda and *Hofmann's violet*.
" " " " *methyl green*, no mordant.
" " " " *methyl green* and tannic acid and tartar emetic.
" " " " tannic acid and stannate of soda and *methyl green*.
Linen " " " *methyl green* and tannic acid and tartar emetic.
" " " " tannic acid and stannate of soda and *methyl green*.
Cotton " " " tannic acid and tartar emetic and *Paris violet*.
" " " " tannic acid and stannate of soda and *Paris violet*.
Linen " " " " " " " " " " "
Spruce " " " " " " " " and *fuchsin*.
" " " " " " " " " and *methyl green*.
" " " " " " " " " and *Paris violet*.
Fibre of filter paper. " " " " " " " and *fuchsin*.
" " " " " " " " and *methyl green*.
" " " " " " " " and *Paris violet*.

PROCEEDINGS.

Meeting of April 6th, 1894.

The President, Mr. Charles S. Shultz, in the chair.

Forty-six persons present.

A communication was presented from the Secretary of the Scientific Alliance, asking the concurrence of the Society in an application to the postal authorities to reduce the postage on mailable scientific specimens, and also in requesting scientific societies in foreign lands to act in the same matter at the approaching postal union.

The Board of Directors unanimously resolved on such concurrence.

Mr. Stephen Helm addressed the Society on "Marine Life." This address, being introductory to an intended series on this subject, was illustrated by numerous enlarged diagrams and dried specimens.

OBJECTS EXHIBITED.

1. Section of chalcedony : by J. D. HYATT.

2. Male and female Copepods from Wood's Holl, Mass. : by H. W. CALEF.

3. Young of *Limulus* from Cold Spring Harbor, N. Y. : by MRS. M. O. LE BRUN.

4. Hydroid form of *Obelia commisuralis* from Cold Spring Harbor, N. Y. : by MRS. M. O. LE BRUN.

5. Sertularian from Cold Spring Harbor, N. Y. : by MRS. M. O. LE BRUN.

6. *Globigerina* from "Challenger Expedition" soundings, 1,450 fathoms : by JAMES WALKER.

7. Male and female forms of pond life from Crotona Park, N. Y. : by F. W. LEGGETT.

ANNUAL EXHIBITION, APRIL 17TH, 1894.

The Fifteenth Annual Exhibition of the Society was held at the American Museum of Natural History, Central Park, New York City, on the evening of April 17th, 1894.

Objects and apparatus, as noted in the programme below, were displayed in the halls of the second floor of the Museum. At 9 o'clock Dr. Edw. G. Love, in the main lecture room, gave an explanation of numerous projections of photomicrographs upon the screen. It was estimated that about two thousand persons were present at the exhibition.

EXHIBITS.

1. Volvox Globator, living ; these hollow vegetable spheres seen in active rotary motion, caused by innumerable cilia arranged upon the surface of the globe : by CHARLES S. SHULTZ.

2. Fossil Coal, section from Bowling-on-the-Clyde, Scotland. From its appearance it is undoubtedly a portion of a Stigmaria plant retaining its original cell structure : by CHARLES S. SHULTZ.

3. Arranged Group of Diatoms forming Pleurosigma Rosette, 130 forms : by E. A. SCHULTZE.

4. Tongue, *Odontophore*, of Snail : by J. D. HYATT.

5. Grappling-hook Spicules of Sponge, *Hyalonema* : by J. D. HYATT.

6. Atacamite (*Chloride of Copper*) : by J. W. METCALF, M.D.

7. Ruby Copper from Morenci, Arizona, shown with an aluminium microscope, weight two pounds. Stage can be lowered to the base to allow use of low-power objectives in searching over large mineral specimens : by PROF. WALLACE GOOLD LEVISON.

8. Circulation of Protoplasm (*Cyclosis*) in the water plant Nitella : by H. S. WOODMAN.

9. Section of Human Intestine from a Case of Arsenical Poisoning : by J. A. GOTTLIEB, A.M., M.D.

10. Longitudinal Section of the Cells of the Endosperm of Ivory Nut, *Phytelephas macrocarpa* Ruiz and Pavon, shown with polarized light, magnified 250 diameters : by REV. J. L. ZABRISKIE.

11, 12. Two Slides of Blood of Amphiuma stained by different methods. In the Amphiuma, as in all amphibia, the blood corpuscles are nucleated and of enormous size compared with those of human blood : by F. D. SKEEL, M.D.

13. Fresh Water Shrimp, *Gammarus pulex*, by polarized light : by WILLIAM WALES.

14. Tooth of Fossil Fish in Coal : by FREDERICK KATO.

15. Eggs of Umbre Moth : by C. H. DENISON.

16. Skin of Sole, by polarized light : by F. COLLINGWOOD.

17. Calamine (zinc silicate) from Franklin Furnace, N. J., by polarized light : by J. W. FRECKELTON.

18. Arranged groups of Diatoms : by GEORGE H. BLAKE.

19. Head of Tapeworm, *Tænia Solium*, showing the Rostellum and Suckers : by L. SCHÖNEY, M.D.

20. Trichina Spiralis, encysted in human tissue : by THOMAS S. NEDHAM.

21. Pond Life : by W. J. LLOYD.

22. Six Sections of Serpentines from different localities, shown on automatic revolving stage by polarized light : by JAMES WALKER.

23. Polycistina from Barbadoes Earth, illuminated by parabola: by JAMES WALKER.

24. Section of Bud of Lily : by HORACE W. CALEF.

25. Opal from Australia : by GEORGE E. ASHBY.

26. Tillandsia (*Hanging Moss*) : by F. W. LEGGETT.

27. Young Spiders : by W. D. MACDONALD.

28. Transverse Section of Optic Nerve of Human Infant : by WILLIAM BEUTENMÜLLER.

29. Transverse Section of Stomach of Frog : by WILLIAM BEUTENMÜLLER.

30. Poison of Viperine Snakes : by RAYMOND DITMARS.

31. Vinegar Eels, living : by A. BEUTENMÜLLER.

32. Palm Leaf, transverse section : by ANTHONY WOODWARD, PH.D.

33. Advertisements, Travelling in Olden Time : by ANTHONY WOODWARD, PH.D.

34. Plasmodium of one of the Myxomycetes : by WILLIAM CRAIG.

35. A living Diatom, *Bacillaria paradoxa :* by CAPT. O. H. WILSON.

36. A New Pond Fishing Outfit for catching Pond Life : by CAPT. O. H. WILSON.

37–39. Etchings of Steel, showing structure : by P. H. DUDLEY and THOMAS B. BRIGGS.

37. Manganese Steel for Car Wheels.

38. A 0.60% Carbon, with 0.18% Silicon, for Steel Rails.

39. A 0.50% Carbon, with 0.15% Silicon, for Steel Rails.

40. Crystals of Silver precipitated on Copper from the Nitrate : by MICHEL M. LE BRUN.

41. Transverse Section of Yellow Water Lily, *Nuphar advena :* by MARIA O. LE BRUN.

42. Crystals of Cinnabar in Chalcedony (opaque) : by ARTIS H. EHRMAN.

43. Young Sea Horse, *Hippocampus Hudsonius*, born in the Aquarium, ten days old : by W. E. DAMON.

43A. Suction Cups from the Arms of the Devilfish (*Architeuthis princeps*), showing the serrated, saw-like edge with which the animal fastens itself to its prey : by W. E. DAMON.

44. Butterfly's Wing, showing arrangement of Scales. Magnified one hundred times : by WALTER H. MEAD.

45. Circulation of Blood in Tadpole of Newt : by A. D. BALEN.

46, 47. Pond Life : by STEPHEN HELM.

48. Mounted Specimen of Larval Sea Urchin, *Arbacia punctulata*, stained with hæmacalcium : by ERNEST V. HUBBARD.

49. Older Larvæ and Ova in Early Segmentation Stages, preserved in Alcohol : by ERNEST V. HUBBARD.

50–53. Microphotographs, selected : by SERENO N. AYRES.

54–58. Animal and Vegetable Fibres, Wool, Silk, Linen, and Cotton : by E. G. Love, PH.D.

59–61. Studies of *Utricularia :* by C. L. POLLARD.

59. Mature Plant.

60. Slide showing the modified leaf forming a bladder-like trap for catching minute animals.

61. Slide showing the organs of digestion.

62–63. Anatomy of the Stem of *Polygonum :* by JOHN K. SMALL.

62. Longitudinal radial section of *Polygonum Persicaria.*

63. Transverse section of *Polygonum aviculare.*

64–65. Histological Features of *Büttneria fertilis :* by T. H. KEARNEY, JR.

64. Section of pericarp of the seed.

65. Transverse section of the seed.

66–69. Study of *Nitella :* by A. E. ANDERSON.

66. Growing plant.

67. Slide showing antheridium and archegonium.

68. Slide showing manubrium, capitulum, antheridial filaments, antherozoids, etc.

69. Slide showing oospore and pericarp.

70–71. 1. Formative Stages of the Thallus of *Cladonia mitrula :* by CARLTON C. CURTIS, PH.D.

2. *Phegopteris Phegopteris :* illustration of the differentiation of the elements of the leaf and the optical penetration that may be secured in histological work.

72. Cuprite (Oxide of Copper) : by H. FINCKE.

73. Gold Ore : by H. FINCKE.

74. Arranged Groups of Diatoms : by H. FINCKE.

75. Microphotograph, the Descent from the Cross : by H. FINCKE.

76. Diamond Beetle : by H. FINCKE.

77. Human Retina : by H. FINCKE.

78. Triceratium Trifoliatum. Diatom from Lloyd's Neck, L. I. This diatom has never been found except at Wellington, New Zealand : by HEINRICH RIES.

79. Melosira Granulata. Diatom Ehr , Ralf's cretaceous clay, from Glen Cove, L. I. : by HEINRICH RIES.

80. Transverse Section of the Head of Embryo Garter Snake, *Eutania Sirtalis :* by LUDWIG RIEDERER.

81. Section of Head of Honey-Bee, *Apis mellifica :* by LUDWIG RIEDERER.

82. Sagittal Section of Abdomen of an Ichneuman-Fly, *Cryptus Samiæ :* by LUDWIG RIEDERER.

83. Sagittal Section of Abdomen of a Dragon-Fly, *Libellula semifasciata :* by LUDWIG RIEDERER.

84. Microtome, manufactured by Aug. Becker, Göttingen, Germany : by LUDWIG RIEDERER.

85. Selections of Serial Sections : by LUDWIG RIEDERER.

86. Exuviated Cuticle from De Kay's Brown Snake, *Storeria Dekay ;* showing cornea, scales, etc.: by HENRY C. BENNETT.

87. Insect Scales, arranged in form of a Vase of Flowers : by G. S. WOOLMAN.

88. Proboscis of Blow-Fly : by G. S. WOOLMAN.

89. Crystals of Copper : by G. S. WOOLMAN.

90. Head of Mosquito, male : by G. S. WOOLMAN.

91. Saw of the Rose Saw-Fly : by G. S. WOOLMAN.

92. Foot of Spider : by G. S. WOOLMAN.

93. Circulation of Blood in a Frog's Foot : by JOSEPH C. THOMPSON, F.R.M.S.

94. Pond Life : by JOSEPH C. THOMPSON, F.R.M.S.

Alcove A.

Six Photomicrographs, selected, taken by the late Gen. Woodward about twenty years ago : by GEORGE H. BLAKE.

Alcove Q.

1. Tongue of Butterfly : by WILLIAM KRAFFT.

2. Hypopus Muscarum, parasitic on flies : by WILLIAM KRAFFT.

3. Calcareous Corpuscles, from *Cucumaria pentactes,* shown with polarized light : by WILLIAM KRAFFT.

4. Asparagine, shown with polarized light : by WILLIAM KRAFFT.

5. Pond Life, consisting of Hydras, etc.: by G. DUPUY.

6. Collection of Designs : by G. DUPUY.

Alcove R.

1. Spider's Foot, illustrated by an accompanying photograph: by P. LYONS.

2. Specimens to be used for Microscopic Mounting (animal and mineral) : by P. LYONS.

3. Sectioned Specimens ; after having been treated and sectioned with microtome ; and minerals ground : by E. J. RIEDERER.

4. Specimens under Microscope, polarized light, and also top-light for mineral and naked-eye drawing : by E. J. RIEDERER.

5. Drawings of Microscopic Objects by the use of Zeiss' Camera Lucida : by G. W. KOSMAK.

6. Camera illustrating Process of Photographing Microscopic Objects with Use of the Microscope : by G. W. KOSMAK.

7. Thyroid Gland, illustrated by charts and drawings : by W. W. BOYD, JR.

8. Human Lung, sectioned with Microtome : by E. GOLDBACHER.

Alcove S.

The Frog and the Fern. Two types of animal and plant life, to illustrate the similarities and differences between these two great divisions or kingdoms of animated nature. The gross and minute structure of each will be examined and explained by charts, microscopic preparations and dissections, with special attention to nutritive and respiratory processes, and the general development of both types : by GEORGE WILLIAM KOSMAK.

MEETING OF APRIL 20TH, 1894.

The President, Mr. Charles S. Shultz, in the chair.

Twenty persons present.

Mrs. Virginia B. Gibbs was elected a Resident Member of the Society.

The Committee on Annual Exhibition presented its report, the report was adopted, and the committee was discharged with thanks.

On motion the thanks of the Society were tendered to those who, although not members of the Society, exhibited specimens and apparatus at the late Annual Exhibition.

On motion the thanks of the Society were tendered President Morris K. Jesup and the members of the Board of Trustees of the American Museum of Natural History for their kindness in granting the use of the halls of the Museum, and to Mr. William Wallace, superintendent of the buildings, and his assistants, for their kind offices on the occasion of the late Annual Exhibition.

Dr. Edw. G. Love read a paper entitled "Notes on the Staining of Cellulose." This paper, published in this number of the JOURNAL, was illustrated by the exhibition of many bottles of stains; by many macroscopic samples of stained fibres (see conclusion of the published article); and by eight slides of mounted stained fibres under microscopes, as noted below.

OBJECTS EXHIBITED.

1. Linen fibre; stained, acetate of alumina and logwood.

2. Linen fibre; stained; mordant, tannic acid and stannate of soda; stains, fuchsin, Paris violet, and methyl green.

3. Cotton fibre; stained, acetate of copper and logwood.

4. Cotton fibre; stained, acetate of alumina and brazilwood.

5. Cotton fibre; stained; mordant, tannic acid and stannate of soda; stains, fuchsin, Paris violet, and methyl green.

6. Cotton fabric, Turkey red.

7. Wool, silk, cotton and linen; mordant, tannic acid and stannate of soda; stains, fuchsin, Paris violet, and methyl green.

8. Poplar fibre; stained, acetate of copper and logwood. Exhibits Nos. 1–8 by EDW. G. LOVE.

9. Living colony of *Megalotrocha:* by JAMES WALKER.

10. Living colony of *Melicerta ringens:* by JAMES WALKER.

Mr. Walker stated that the water and mud supplying the colony of *Melicerta* were collected six weeks since and were placed in glass battery jars. The water of this particular jar was changed after four days. He lately found fifty colonies of *Melicerta* attached to the sides of the jar; but four days previously he could

find none. These specimens built their tubes with remarkable rapidity. Large aquatic worms infested all the colonies, writhing amid the bases of the tubes, and continually startling the rotifers to contraction, as could be seen under the microscope.

Meeting of May 4th, 1894.

The President, Mr. Charles S. Shultz, in the chair.

Sixteen persons present.

Mr. James C. Gregory was elected a Resident Member of the Society.

The Recording Secretary read a communication from the Council of the Scientific Alliance requesting the concurrence of the Society in the arrangement of a co-operative course of ten lectures, to be delivered at the American Museum of Natural History or the Cooper Union Building. On motion such concurrence was granted.

The Recording Secretary read a communication from the Citizens Committee of Brooklyn on Entertainment of the American Association for the Advancement of Science, inviting the Society to attend the receptions, meetings, and excursions of the Association. On motion the invitation of the Citizens Committee was accepted with thanks.

Mr. James Walker reported for the Committee on Uniform Cases, Drawers, Trays, and Labels, and the report was accepted and adopted.

Objects exhibited.

1. Rare living form of *Hydra* with rudimentary tentacles : by Henry C. Bennett.

2. Living *Plumatella*, developed from statoblast in aquarium : by James Walker.

3. Living *Fredericella* from Croton water : by A. D. Balen.

4. Section of Labradorite : by George E. Ashby.

From the Society's Cabinet.

5. Sunstone : aventurine feldspar, internal reddish, fire-like reflection from disseminated crystals of hematite or gothite.

6. Aventurine, artificial ; glass mixed with filings of copper.

7. Hypersthene; silicate of magnesia containing iron.
8. Oölite from India.
9. Oölitic sand from Great Salt Lake.

Mr. Ashby said of his exhibit of Labradorite: "The play of colors, especially remarkable in much Labradorite, indicates, according to Reusch, the existence of a cleavage structure of extreme delicacy, transverse to the median or brachydiagonal section. The play of color appears to be that of thin plates; yet the linings of what he regards as a cleavage system appear to be of indistinguishable minuteness; and although the existence of thin plates can hardly be established by means of the microscope, it is proved by their effects in the play of colors, nebulous images within, and the phenomena of inflection or diffraction which result from their regular grouping. This play of colors is independent of the disseminated microscopic crystals of foreign substances which occasion the aventurine effect."

Meeting of May 18th, 1894.

The President, Mr. Charles S. Shultz, in the chair.

Eighteen persons present.

The Recording Secretary read a communication from the American Geographical Society relative to the Sella collection of mountain photographs now on exhibition at the American Museum of Natural History. The Recording Secretary stated that he had replied to this, and had received tickets of admission which he would distribute to the members. On motion the Recording Secretary was directed to express the thanks of the Society to the American Geographical Society.

The President called the attention of the Society to the proposed meeting of the American Microscopical Society, to be held in Brooklyn three days before the meeting of the American Association for the Advancement of Science. After an address on the subject by Mr. George S. Woolman, and the reading by the Recording Secretary of a communication from the Secretary of the American Microscopical Society to Mr. Woolman asking for information regarding accommodations, on motion the Chair appointed the following committee to consider and report any

possible action on the matter: Dr. Edw. G. Love, Messrs. George S. Woolman and L. Riederer.

OBJECTS EXHIBITED.

1. Mounts, *in toto*, of chick embryos of 36 and 54 hours' incubation: by GEORGE W. KOSMAK.

2. Series of cross-sections of the 54-hour embryo: by GEORGE W. KOSMAK.

3. Insect in amber: by JAMES WALKER.

4. Living embryo leech: by HENRY C. BENNETT.

5. Living *Plumatella:* by A. D. BALEN and FREDERICK KATO.

6. Curious green-colored sand from Kentucky: by F. D. SKEEL.

7. Insect in fossil gum copal from Zanzibar, Africa: by GEORGE E. ASHBY.

Mr. Kosmak explained the method of preparation of his sections of chick embryo.

MEETING OF JUNE 1ST, 1894.

In the absence of the President and the Vice-President, Rev. J. L. Zabriskie was elected Chairman.

Fifteen persons present.

Mr. E. Gerber was elected a Resident Member of the Society.

The Recording Secretary read the report of Mr. George S. Woolman, of the Committee on Entertainment of the American Microscopical Society, stating that the said society would be accommodated at the Polytechnic Institute, Brooklyn. The report was accepted and adopted.

OBJECTS EXHIBITED.

1. Serpentine from Meissen, Saxony, polarized: by HENRY C. BENNETT.

2. Sunstone: by F. D. SKEEL.

3. The common scarlet leaf-hopper, *Diedrocephala coccinia* Först., entire: by J. L. ZABRISKIE.

4. Hairs of sea mouse, *Aphrodite aculeata:* by H. W. CALEF.

5. Pond life: by JAMES WALKER.

6. Living cheese mites: by THOMAS S. NEDHAM.

7. Living *Pectinatella magnifica:* by A. D. BALEN.

Meeting of June 15th, 1894.

The President, Mr. Charles S. Shultz, in the chair.

Thirteen persons present.

The Corresponding Secretary read a communication from Mr. K. M. Cunningham, dated Mobile, Ala., June 7th, 1894, announcing to the Society that he had, in a manner most satisfactory to himself, just succeeded in perfecting the proof that the diatom belongs to the animal kingdom.

OBJECTS EXHIBITED.

1. Section of conglomerate from the drift of Long Island, N. Y.: by James Walker.

2. The curious parasitic wasp, *Ceratomus* sp.? by J. L. Zabriskie.

3. Flowers of *Vincetoxicum acuminatum* with captured mosquitoes: by T. B. Briggs.

4. Androconium scales of wing of the butterfly, *Pieris rapæ:* by E. G. Love.

5. Circulation in *Nitella*, from Crotona Park, N. Y.: by F. W. Leggett.

6. Living *Volvox globator:* by A. D. Balen.

Objects from the Society's Cabinet.

7. Group of foraminifera.
8. Group of foraminifera and spicules.
9. Group of foraminifera, *Spirolina austriaca.*
10. Foraminifera from the Levant.
11. Section of orbitolite.
12. Section of *Polystomella scrobiculata.*

Mr. Briggs stated that his specimen of *Vincetoxicum* was from the gardens of Mr. Charles A. Dana. The mosquitoes are attracted and held captive by the very viscid nectar of the flowers.

Dr. Love with blackboard drawings explained the situation and structure of the "androconium" scales of the butterfly wing. They are found only on the wing of the male, and are supposed to be scent organs.

Mr. Leggett said that his specimen of *Nitella* was taken from a small pool of exceedingly foul water in Crotona Park, where the plant was growing in astonishing luxuriance.

Mr. Balen stated that his specimens of *Volvox* were also taken from a pool with water so foul that the *Volvox* could not be seen. They appeared to thrive under the circumstances, and many specimens showed that they contained within an astonishing number of young forms.

The Society adjourned to meet on the first Friday of October, 1894.

AN INTRODUCTION TO STRUCTURAL BOTANY. By DUKINFIELD HENRY SCOTT, Jodrell Laboratory, Kew, London. 113 figures. London: Adam & Charles Black, 1894. Pp. 288. Price, $1.

This is intended to be a first guide to the study of the structure of plants in schools. It treats of three types of phanerogams—the Wallflower, the White Lily, and the Spruce Fir—and seems well adapted to its purpose.

PRACTICAL BOTANY FOR BEGINNERS. By F. O. BOWER, Professor of Botany in the University of Glasgow. 13 figures. New York: Macmillan & Co., 1894. Pp. 275. Price, 90 cents.

An excellent condensed guide to biological laboratory work for beginners, conducting them through the microscopical examination—sectioning and mounting—of many selected types of plants, from the highest to the lowest orders.

A MANUAL OF MICROCHEMICAL ANALYSIS. By PROF. H. BEHRENS, Polytechnic School, Delft, Holland, with an introductory chapter by PROF. JOHN W. JUDD, Royal College of Science, London. 84 figures. New York: Macmillan & Co., 1894. Pp. 246. Price, $1.50.

The English translation of this work is by the author, Prof. Behrens, and it is devoted mainly to the qualitative microchemical wet methods of the examination of the rock-forming minerals. Part I. contains the general method, and the reactions of sixty-three minerals. Part II. contains the analytical examination of mixed compounds. The work is one of Macmillan's Manuals for Students, under the division of chemistry, and is a late summarization of the labors of most eminent men in this branch of study. To those who are engaged in crystallography and petrography it would seem to be invaluable.

SYSTEMATIC SURVEY OF THE ORGANIC COLORING MATTERS. By G. SCHULTZ and P. JULIUS. Translated and edited with extensive additions by ARTHUR G. GREEN, London Institute, London. New York: Maxmillan & Co., 1894. Pp. 205. Price, $5.

This work is devoted to the exposition of the products of coal tar. It states that the average quantity of gas tar worked up per annum by the whole world is 530,000 tons. In three divisions it explains the manufacture and gives the formulæ of the raw products, the intermediate products, and the coloring matters; under this latter division tabulating 454 colors by means of parallel columns under the headings: commercial name, scientific name, empirical formula, constitutional formula, method of preparation, year of discovery, discoverer, patents, literature, behavior with reagents, shade and dyeing properties, method of employment.

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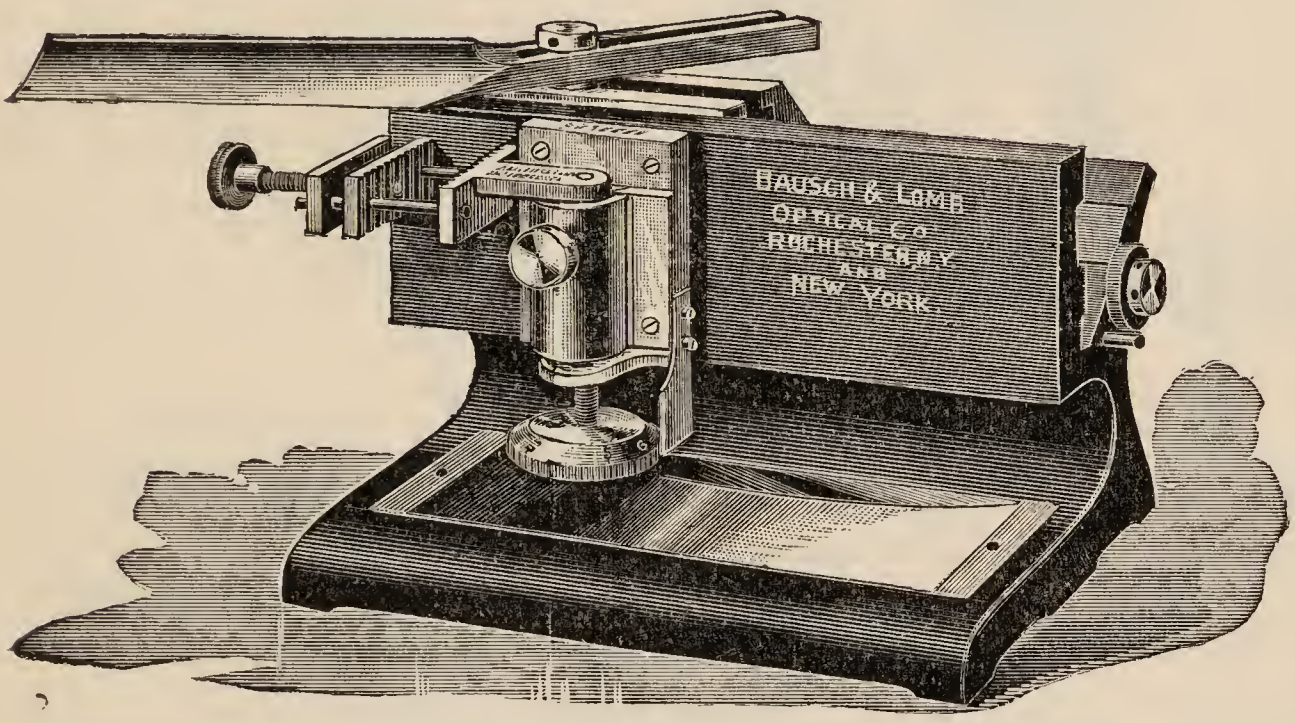

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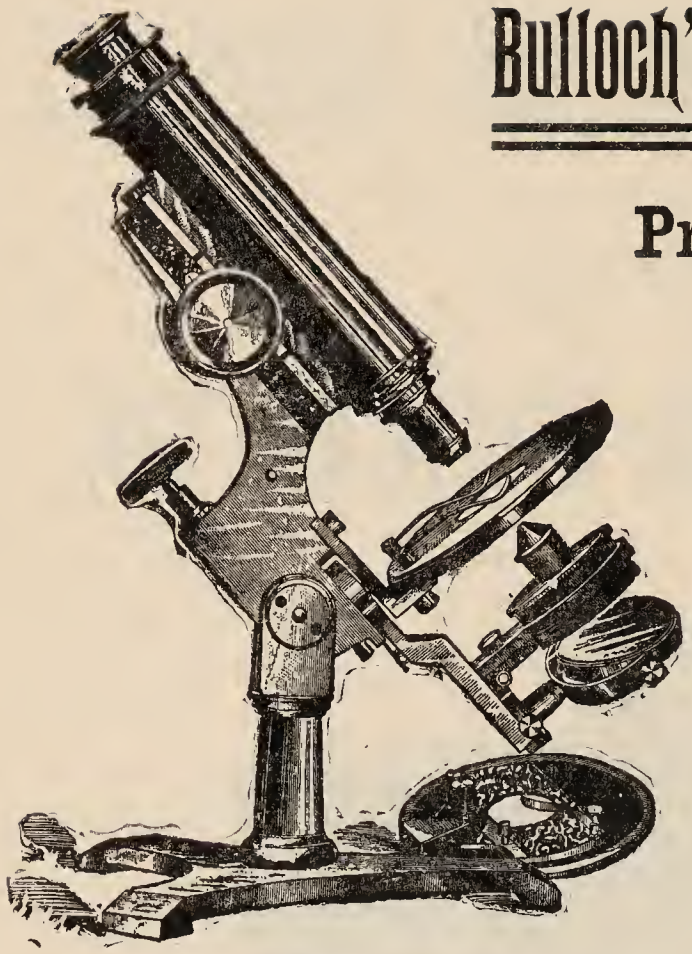

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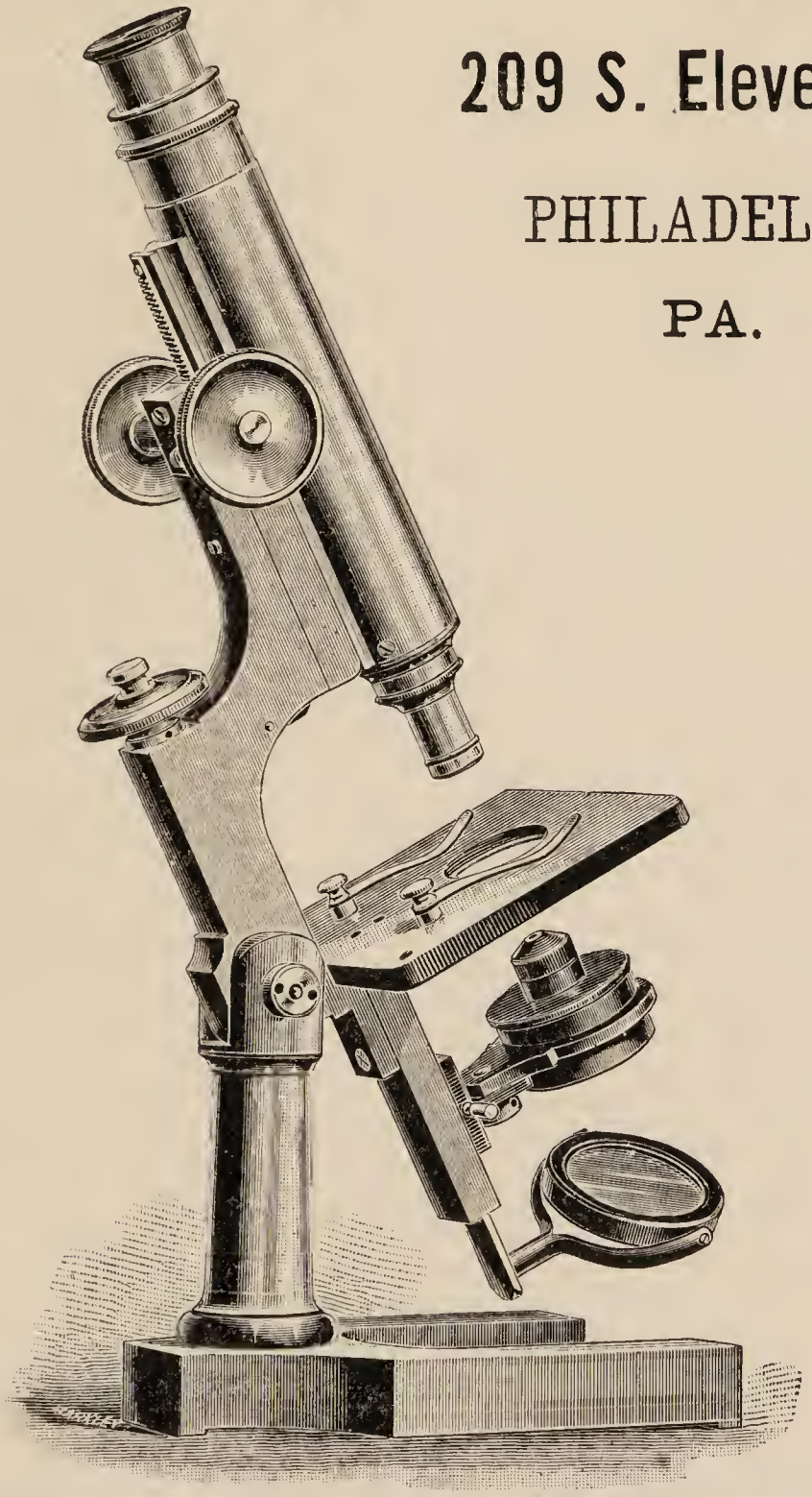

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